Soan Tool Types from Ghila Kalan

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The assemblage described in this paper consists of 216 pieces of fractured stone collected from the exposed surface of a boulder conglomerate at the Soan River site called Ghila Kalan. The collection was made in 1964 by Elden Johnson from a localized area adjacent to a weathering loess cap on the most northerly section of the second terrace at Ghila Kalan. An area measuring approximately 50 m square furnished this sample and all stone showing any fracturing was collected. Almost all of the stones in the assemblage are of quartzite, usually light yellow-brown and with a cortex typically 5 or 6 mm thick. Patination on fractured surfaces is very slight, as seen from a few recent chippings. Fracturing qualities of the quartzite are fairly good, judging from the workmanship, and very few internal impurities were noted.

Other materials include a more cherty or flintlike finer grained material, sometimes almost white but occasionally including reds or yellows. Such material is rare and does not tend to occur with any emphasis in any particular type of tool.

All of the collected stones appear clearly to be of human workmanship. In some cases a chip or more may be of natural origin as indicated by greater patination, but almost all have been worked to some degree toward some intended form. The few exceptions to this last statement are a small group (19) of flakes which do not conform to any type noted in the collection, or elsewhere for that matter. These flakes can easily be ascribed to accidents of flaking not intended by the tool makers, but were of some potential utility anyway.

An interesting aspect of this collection is that virtually all of the specimens are usable tools, and there are no manufacturing wastes. This clearly does not represent a workshop site in any sense. Had it been so, the collector would have noted, if not collected, waste flakes of no utility which should have far outnumbered finished tools. Also, many unfinished, broken and rejected tools, hammerstones, and cores

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should have been in evidence. The nature of this collection instead gives evidence of the tools having been utilized and presumably abandoned at the site of their discovery.

Before describing the major part of the collection, I must say a few words about six of the specimens whose physical condition is markedly different from the remainder. These specimens show deterioration which could reasonably be taken to indicate greater age.

Three of these might be called hand-axes, though in one case such a designation somewhat strains the imagination. All three are heavily rolled, showing no sharp edges and only little evidence of the pattern of flaking that gave them their form. They can be described as having cortex on all surfaces. Two of these hand-axes seem substantially more rolled than the third. These occurrences are fully in accord with the observations of Sen (1954:133) that bifaces (hand-axes) in some regions precede the occurrence of Soan industries.

Two other rolled specimens are of types common to the main assemblage. These are "discoidal flakes," a term to be explained below. They do not appear to be as rolled as the hand-axes, and the flaking procedures of their manufacture can be at least estimated. That they are more recent than the hand-axes can, however, only be surmised, not proven.

The last specimen of this group is again one typical of the main assemblage, a pebble tool, but its type might well be expected in any group of Paleolithic tools. Its condition is different from the other five in that it seems to be decomposing from the surface inwards. This may be a result of its being of a different material and not an indication of special antiquity.

After these first six specimens, the main assemblage of 210 tools has been broken down into the following five categories:

34 Pebble tools or choppers
105 "Discoidal flakes"
34 Levallois-like flakes
16 Blades, or parts of blades
21 Indistinguishable pieces

These categories will now be separately described and subdivided to the degree deemed necessary for this report.

Before getting into the actual descriptions it is necessary to say something about this writer's approach to the basis for tool typologies. The classic approach is well stated by H. L. Movius, Jr., who has said that "The terminology used . . . is based entirely on the form and technique of manufacture of the tools themselves. These, rather than any hypothetical functions, are considered to be primary criteria" (1948:349). A page later, Movius adds, " . . . since the classification adopted in this paper is the work of the writer and *not* of the people who made the tools, the system used here has been established solely for the purposes of facilitating the description of the implements themselves . . ." (1948:350).

In general, the foregoing attitude is admirable, but I think more can be done. If one classifies tools according to manufacturing techniques one is actually using a classification of the people who made the tools. It is not likely that the tool makers were unaware of using distinctly different techniques in their own work.

Classifying by shape or form of the tool is another matter, and I think a rather dubious one. It is not difficult to divide a continuum of shapes into describable groups, but if these groups meant no more than accidental variations to the makers, I fail to see that anything of value is accomplished. Only where there is a distinct hiatus in the tool form continuum, or at least a point of markedly low frequency, can one reasonably infer a division into tool types which was meaningful to the makers. Conversely, where no such break is evident, it would be better to treat the full range as a unit rather than risk arbitrary distinctions that may be quite different from those the makers might have had in mind.

Often the nature of the cutting (or scraping) edge of the tool was all that counted, the rest of the stone being quite variable in its forms for no deliberate reason at all. Such variations, if catalogued, might be taken to indicate a diversity of tool types where in fact only one existed. This is not to say that one can always deduce the exact tool categories originally made, but a good attempt can be made. I feel it is better to err in lumping a few intended tool types than to err by separating some which do not really exist.

Finally, a few words about the "hypothetical functions" which Movius would prefer to avoid. All the actual functions of a series of paleolithic tools may never be known, but they need not remain entirely hypothetical. The approach advocated here is that the worker himself simply make a few of the tools in question and proceed to use them in some manner thought possible. By this means certain uses might be eliminated, though it may not necessarily prove the use of others. This will be touched upon later in connection with the series of stone tools at hand.

Pebble Tools or Choppers

Of the 210 main tools, 34 of them, or 16.2 percent, are what have been variously termed pebble tools, choppers, or chopping tools. These are the well known flat river pebbles which have been given a short cutting edge by the removal of several flakes from one or both surfaces of the stone (Fig. 1).

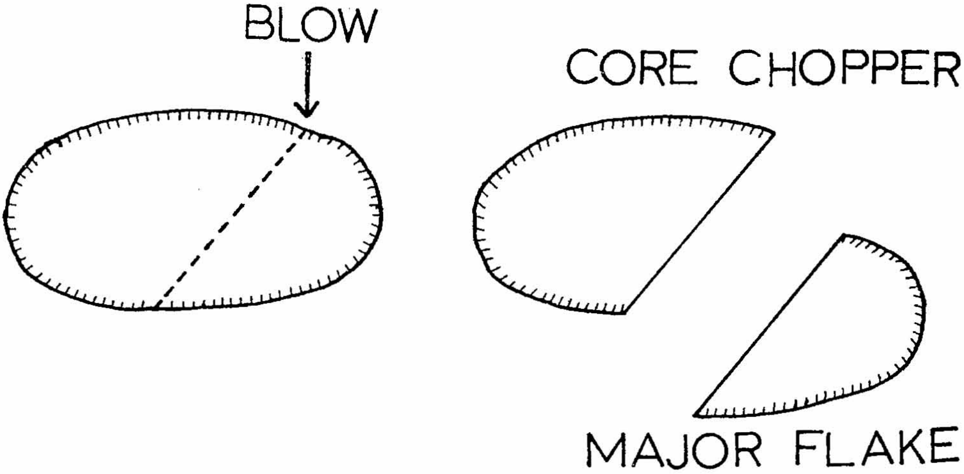

Fig. 1 Chopper Manufacture. Symmetrical pebble is struck (perhaps on anvil) and a major flake removed. Either the core or the flake, if it is large enough, may be further worked from the first flake scar to make a bifacial chopper.

Four of these are only unifacially worked; the other thirty are worked from both surfaces to form a cutting edge with flake scars on both sides. The relative numbers may be significant, as the former have a cutting edge which includes the cortex of the pebble, perhaps a not-so-desirable condition. This is usually corrected by striking off another group of flakes so that the cutting edge consists entirely of "interior" stone, apparently sharper.

These tools are the same as those Movius (1943) describes as "choppers" (uniface) and "chopping-tools" (biface). They are also what Sen (1954) calls "pebble scraper" and "pebble chopper," respectively.

The same contrasting types in the earliest African sequence are often termed Kafuan for the unifacial and Oldowan for the bifacial type. J. D. Clark (personal communication) has indicated that the distinction in African tools might in part be based on the thickness of the pebble: a thin piece can be given a sharp edge with one row of flakes removed, while a thicker piece must be turned over for more flaking to achieve a comparable result. This is clearly not the case for the Soan tools, however, where both thick and thin pieces are worked in both ways.

Some of the pebble choppers are peculiar in that the flakes from one surface are long and flat, removing most of the cortex, while those on the opposite surface are only about one-fourth as long. This gives the edge an almost chisel shape. I am inclined to think that this was not a desired result, but followed from the shape of the implement after the first flakes were removed. The first operation often left a plano-convex shape, cortex on the convex side. In removing more flakes by striking the flatter flake scar surface, short, steeply angled flakes automatically resulted.

There are a number of variations in total shape of implement among these pebble choppers. Such variations are treated as significant tool types by Sieveking (1958), Kretzoi and Vértes (1965), and Leakey (1967). Though I doubt there is much, if any, significance to these variations, they will be here briefly described.

If the original pebble has a notably long axis (as opposed to being circular), the cutting edge may be made across the end (perpendicular to the long axis), or along one side (parallel to the long axis).

In more nearly circular, flat pebbles the distinction is lost, but sometimes two cutting edges may be made at about right angles to each other. This produces what might be called a proto-hand-axe appearance, though the relationship is not real. Had the Soan tool makers any inclination or desire to make a hand-axe they could have done so quite easily with their techniques. Clearly the hand-axe was a tool design for which they had no use.

Some pebble choppers are of mixed type. These are bifacially flaked on part of a cutting edge, but the flaking then continues on only one side. Thus they are partly unifacial. Such cases have been classed as bifacial whenever they occur.

The next variation to be described is one that I feel might have some functional significance. For lack of better terms these will be called "straight edges" and "angled edges." If one handles the pebble chopper, its approximate center of gravity, or mass, is easily determined. Then a line can be drawn (mentally) from the the center of gravity to about the midpoint of its cutting edge. In many cases this line is perpendicular to the cutting edge (straight edge), but sometimes it meets the cutting edge at an angle of 70° or less (angled edge). This variation seems to be independent of all other variations. In the case of the straight edge, the form of the implement is functionally similar to a modern steel axe head; the inertia of the tool, if a powerful blow is struck, tends to drive it directly into the cut that is made with no tendency to slide along the cut or to twist out of it. This is relevant to some wood chopping experiments to be described later. In the case of the angle edge, such a strong chopping action would not be practical. This latter tool might better be described as a single-edge knife blade or cutting tool with some degree of a point in many instances (Fig. 2). A careful count was not made, but both types of edge to center-of-mass relationship were well represented, neither predominating in this series.

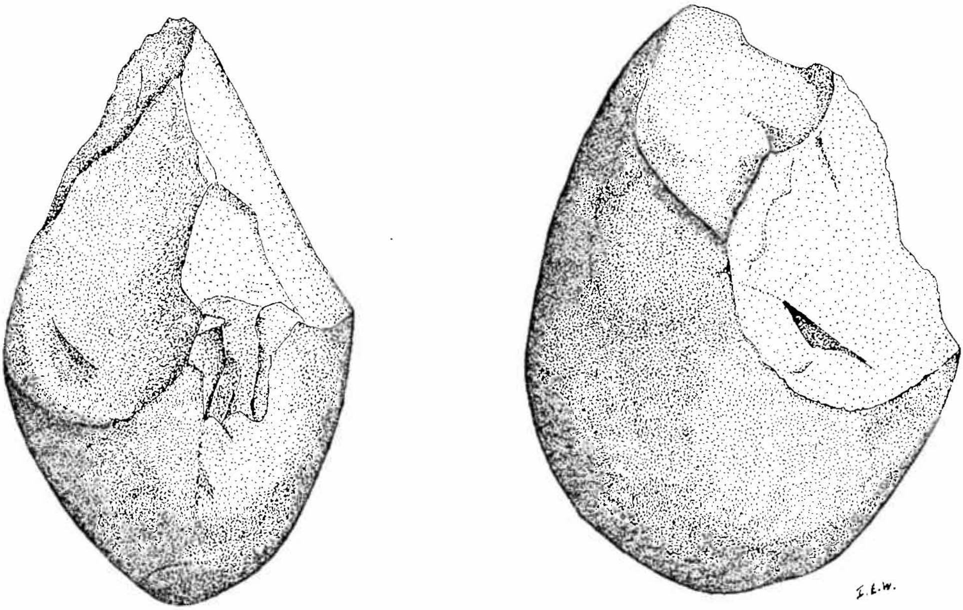

Fig. 2 Soan Chopper. Drawings of typical bifacial chopper with "angled edge."

A final type of peculiarity noted best in just three specimens is that the cutting edge is not just a line, or two lines meeting, but has been carried around at least half of the pebble's circumference. Here the tool begins to resemble the Mousterian discoidal core, though I think the resemblance is only fortuitous. These tools are bifacially worked and an almost circular cutting edge around a flat stone is produced. While these tools were made by extending the distinct pebble tool technique, their form more approximates those of the next, and major, category of tools, which I call "discoidal flakes."

Discoidal Flakes

In these tools we find the major emphasis of this Soan tool tradition; "major" on the basis of both their numbers (50 percent of this series) and a rather unusual method of manufacture.

Basically, the discoidal flakes are approximately circular flakes of stone with a cutting edge produced as far around the circumference as can be done. Ordinarily their thicknesses range from just over half the diameter to less than one-fourth of it.

In total size they range from a diameter of about 3 cm to over 10 cm, with no apparent breaks into size categories. Most have some preparation of the cutting edge around more than half the circumference, but some show only minimal work, often because the original flake edge may have been largely satisfactory for the intended use.

At least eight different kinds of discoidal flakes can be described according to details of the manufacturing process. In addition to these variations there is also the very human phenomenon of a range from "just adequate" tools on up to "ideal type" tools, which can easily be recognized.

In some instances the making of a pebble tool and a flake tool may have overlapped. Often one or more of the flakes struck from a cobble might have been usable as potential tools. One could argue that it made little difference to the toolmaker whether his nodule or one of the flakes was selected for further work. Most of the flake tools in this series are too large to have resulted from the known pebble-tool making, but a few could have just such an origin.

In some cases it is difficult to determine if the tool is of core or flake origin, especially if it represents (as deduced from cortex curvature) close to half of the original pebble. If the primary flake scar shows enough detail to determine its direction, this distinction can be made. In doubtful cases it may have been of no significance to the maker anyway, as he would have been able to treat each half in the same manner. In this study all tools that were determinably flakes were so classified, even though further treatment looked more like that afforded core tools. The uncertain cases (2 or 3) were counted as pebble choppers (Fig. 1).

All discoidal flakes fall easily into one or the other of two categories which are of questionable importance. If the flake was the first to be removed from the parent stone, or at least the first from a particular part of that stone, the blow that removed it had to have been struck on cortex. The resulting flake then has its surface of cortex curving around one edge onto the other surface to the point where the removing blow was struck. I have termed this "cortex wrap-around." On the other hand, if the flake was struck off from the flake scar of a preceding flake, then its cortex surface will not extend around to the other face (Fig. 3).

It is possible that in a few cases flakes with cortex wrap-around have received enough secondary trimming to remove the evidence of that cortex, and thus may be classed with those noted as lacking such wrap-around. This would be the most difficult part of the edge to trim away, so such cases would be few. The distinction is not important.

Since most of these flakes received considerable secondary trimming, they may be further subdivided into four categories on the basis of where the trimming was done (Fig. 3). The 105 discoidal flakes thus fall into the following eight categories:

	WITH CORTEX WRAP-AROUND	WITHOUT CORTEX WRAP-AROUND	TOTAL
Neither surface flaked	5	9	14
Cortex surface flaked	12	4	16
Fracture surface flaked	8	1	9
Both surfaces flaked	43	23	66

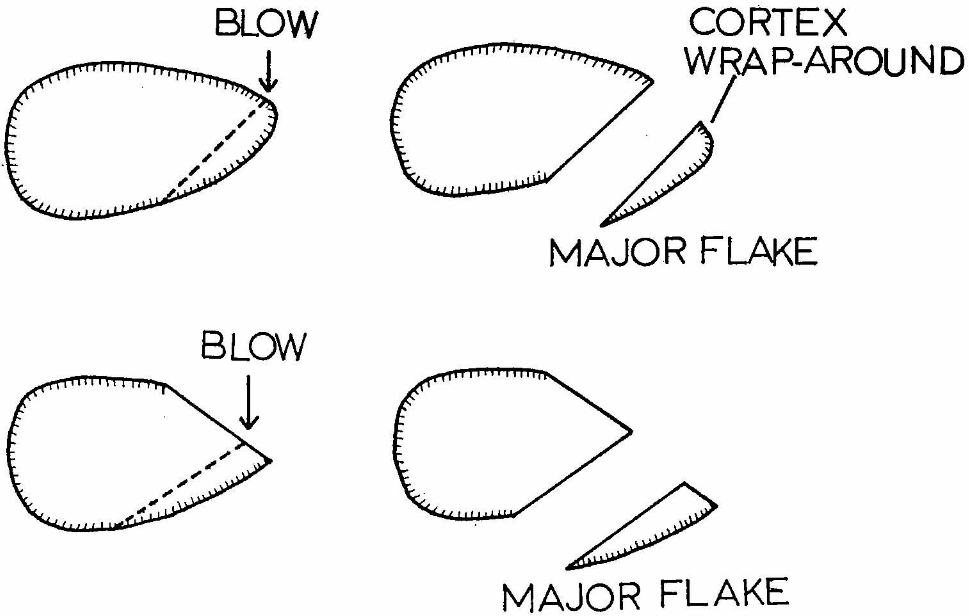

Fig. 3 Major flake production. Pebble or larger stone is struck near its thinnest edge *(above)*, which removes a flake with cortex wrap-around. The same stone may then be turned over and struck in the flake scar *(below)*, which removes a flake without cortex wrap-around. Either kind of flake may then become a discoidal core. The remaining core may become a tool or be discarded.

A total of 14 flakes received no secondary trimming other than that which looks like use-flaking. So $13\frac{1}{3}$ percent of these flakes were used with no further preparation.

Sixteen pieces (15.24 percent) had at least some part of their circumferences trimmed by removal of flakes from the cortex surface only. This produces an edge of internal stone, presumably with a cutting quality superior to that with cortex involved. These tools sometimes look like miniatures of some of the pebble choppers with quite asymmetrical edges. As with the larger tools, the second set of trimming flakes must be delivered at an odd angle, and a chisel edge results.

A somewhat smaller group of 9 tools (8.6 percent) was trimmed only from the primary fracture surface. In these cases the secondary flakes were removed by striking the cortex surface near its edge and thus removing flakes from the fracture surface of the main flake. This treatment produced a more nearly symmetrical cutting edge but still has the drawback of including cortex in the edge. From the numbers involved this would seem to have been a little-used procedure.

The most obvious procedure to avoid both of the foregoing difficulties would be to trim the flakes from both surfaces. Although this involves more work, it was clearly the favored means, as 66 of the tools (almost 63 percent of the discoids) were made with this double trim (Fig. 4).

Not all of the "bifacial discoidal flakes," as they might be termed, were completely finished to what appears to be the ideal type. Any tool which showed at least some attempt at bifacial working was counted in this group, though in many cases only a third of the circumference was properly worked. At least 43 of them were not

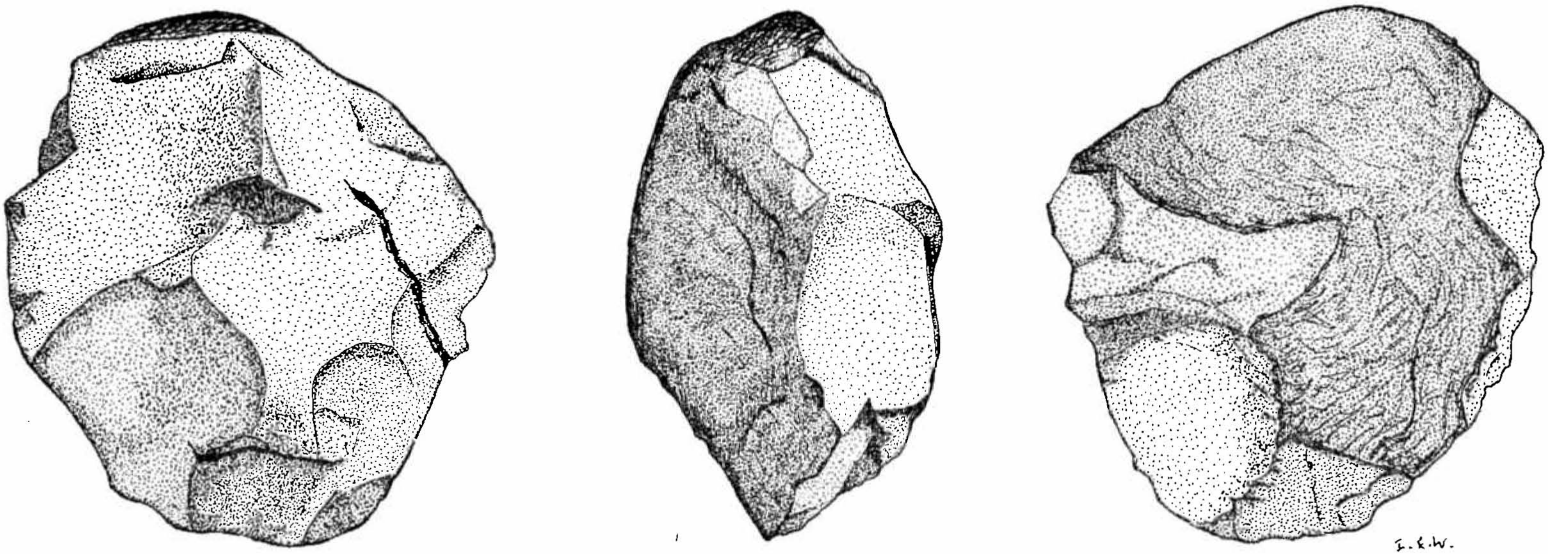

Fig. 4 Discoidal flake. Drawings of 3 views of typical discoidal flake with flakes removed from both surfaces and showing cortex wrap-around.

completely ideal forms since they exhibited cortex wrap-around. Nonetheless, it is clear that the intention of the stoneworkers was to produce a sharp cutting edge, preferably without cortex, and with no regard for the total shape of the implement (Fig. 5). The prevailing circular form automatically follows as the most economical in raw material and least vulnerable to breakage.

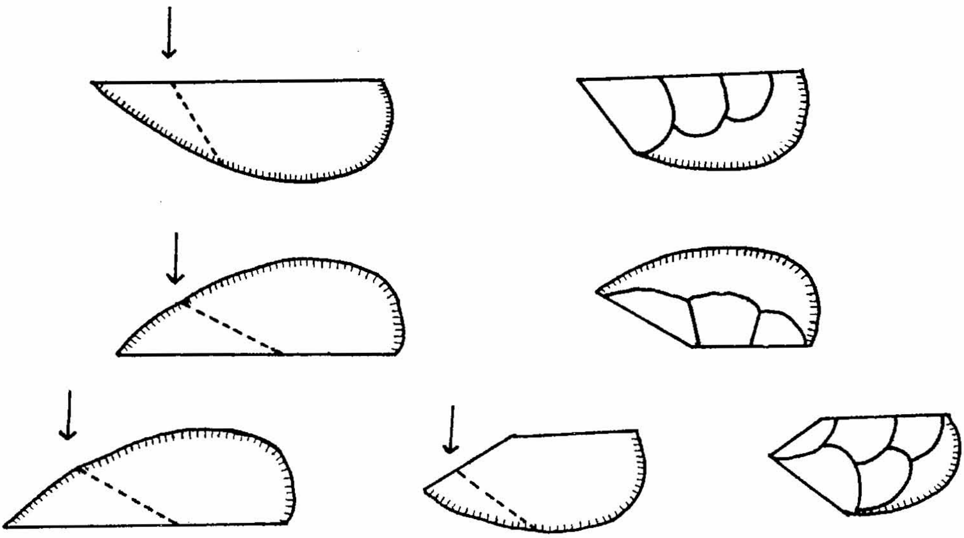

Fig. 5 Trimming discoidal flakes. *Top:* Major flake is struck on cleavage surface removing flakes from cortex only. Edge is not symmetrical. *Middle:* Major flake is struck on cortex surface removing flakes from cleavage surface only. Edge is composed of cortex on one side. *Bottom:* Major flake is struck on both surfaces (either may be done first) removing flakes from each side. Resulting edge is both symmetrical and composed of internal stone only. (All 3 illustrations are with cortex wrap-around and thus are not worked around entire periphery.)

Clearly no significant depth of penetration was involved in the cutting uses to which these discoids were put. Had deep penetration been required, some elongation of the tools would and could easily have been produced.

It is interesting to note that late in the Acheulian hand-axe tradition a form called an "ovate" occurs that functionally approximates these discoidal flakes. Unlike the usual hand-axe design, the ovate form is without a point or any pronounced elongation for cutting in depth. Although the ovate manufacture is quite different, its near circular outline with a cutting edge around the entire circumference is just what the Soan tool makers were after.

It might be noted at this point that to effectively hold and cut with one of these discoidal flakes one must grip it quite firmly between the thumb and the side of either of the next two fingers. A strong thumb grip also would appear to be essential in effectively using an ovate to cut with. On the other hand, effective manipulaton of most hand-axes as cutting tools can be done with the fingers only by pressing the tool against the palm and cutting with the tip that protrudes from the closed hand. Nor do the pebble tools require a well-developed thumb for their wielding. (The writer established this last point some years ago by giving a pebble tool to a young gorilla, who gripped it between fingers and palm and resisted all efforts to have it removed.)

LEVALLOIS-LIKE FLAKES

The third major tool type consists of a fairly typical series of flakes made in the Levallois tradition (Fig. 6). These number 34 pieces, or about 16.2 percent of the 210-item series. These tools show surface flaking that had to have been done prior to detaching the desired flake, as the scars of these surface flakes are incomplete. Also, the striking platforms are prepared and generally at about right angles to the main flake surface, a not-too-easy accomplishment.

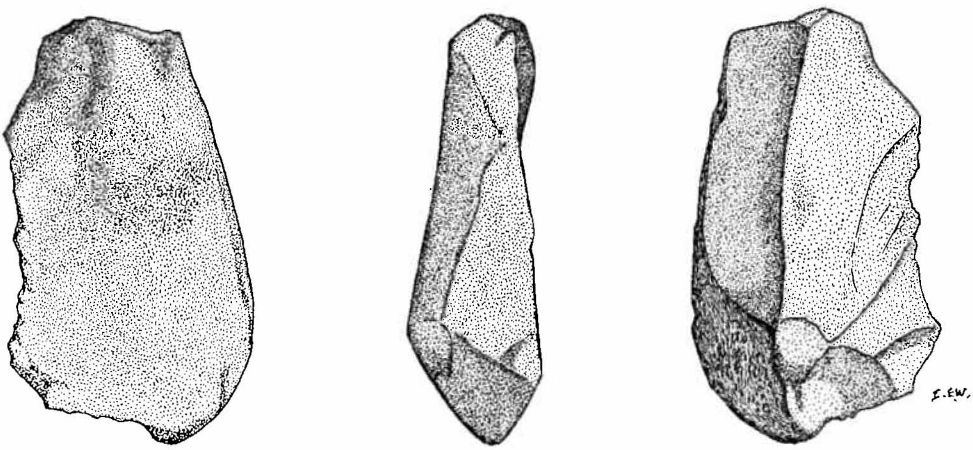

Fig. 6 Levallois-like flake. Drawings of specimen showing prior surface trimming and striking platform at near right-angles to flake surface.

There are a few peculiarities in this group that merit some further discussion. Four of the flakes are evidently bipolar; a second bulb of percussion is evident on the opposite end of the flake surface from the striking platform and the primary bulb. In these cases the core had evidently been rested on a hard surface when the final detaching blow was struck. The impact of the blow forced the core against this surface strongly enough to start a fracture upward through the core, and incidentally in the same plane as the fracture from above.

As it is an unusual event that the upper and lower fractures would be in the same plane and thus both show on the single flake, it may be assumed that others were similarly placed and struck, with no evidence of this remaining. It is quite possible that if four flakes show this practice, the other thirty failed to show it only by chance.

No cores from the production of these Levallois-like flakes were collected, giving further evidence that this was not a workshop site. However, at least one discoidal flake is a second generation specimen. That is, from a prepared core one flake was struck, then a second, much larger flake was struck in another manner which then carried the scar of the smaller Levallois-type flake on its surface. The larger flake (which was found) thus represents, in part, the original core.

A common peculiarity of these Levallois-like flakes is that the prior surface preparation is not always from all directions toward the center. There is a strong tendency for many of the flakes to be from the same direction—the same direction from which the main flake was finally removed. Because of this it was often almost an arbitrary decision whether a flake was of Levallois design or if its parallelism was marked enough to class it as a blade. Another describer might well shift 4 or 5 pieces from either category to the other. Seeing this transition in a single series suggests a simple origin of blade making, but this writer would not like to stress the point.

BLADES

Sixteen pieces of stone are quite parallel-sided, polygonal in cross section and devoid enough of cortex to be classed as blades. As these are only 7.6 percent of the total they seem to be of little significance. However, in view of the gradual transition from Levallois-like to blade flakes, it might be reasonable to think of the two groups combined. Together they number 50 pieces, or a much more respectable 24 percent of the tool series. Further, one might note that blades constitute only one-third of this combined group, so they still are not an important tool as such.

Two of the blades also show evidence of bipolar flaking. By the same reasoning as above it can be assumed that all blade production was probably done on a hard surface. This is further supported by the fact that several of the blades are just short segments of longer pieces from which bipolar evidence is necessarily missing.

None of these blades seems to have clear secondary chipping of any purposeful design, and only one seems to have an edge partly battered away to a degree beyond that resulting from heavy use. No subdivisions into types can be made except to note that they vary a great deal in size and none are very small.

INDISTINGUISHABLE PIECES

This is an ever present category in any classification which includes all pieces that cannot reasonably be put into any other type. Here the group consists of 19 flakes and two cores of some sort. The flakes are simply unassignable and probably represent accidents in the production of standard types. They are comparatively rare, an argument against workshop conditions, and it is suggested here that they were retained because they showed functional shape.

The core tools include one which is simply a split pebble and another which is quite worked but in no pattern which shows through. The last item could easily be the result of idle stone battering or a child's experimenting with adult activities.

This completes the basic tool description except for evidences of use, which will be discussed later.

COMPARISONS WITH OTHER DESCRIPTIONS

Movius (1943, 1948) described Soan-type tools with a clear emphasis on the larger core tools rather than on the flakes, as has been done here. Perhaps this resulted from the nature of his collections, which showed less diversity of form in the flakes. His "choppers" and "chopping-tools" are now universally recognized even though many balk at the names. His other two main types, "hand adze" and "proto hand-axe," are not evident in this series as clear-cut types, though these names might be applied to individual large specimens of poorly made discoidal flakes. Further categories of "flake tools" and "utilized flakes" are far too broad for direct comparisons with the types described here.

Paterson and Drummond (1962) made a more detailed classification of Soan tools, at least as far as flake tools are concerned. Their division into "flat bases" (split pebbles with further work), "oblates" (Movius' "choppers"), and "nucleates" (mostly "chopping tools") cuts across any core tool/flake tool dichotomy. These types, with a total of eight subdivisions, are clearly based on the appearance or shape of the tools, and relatively less attention was paid to the logical categories from the point of view of manufacturing.

Sieveking (1958) has offered another detailed subdivision of a similar series of tools, the Tampanian of Malaya. Here the stated basis of tool categories was "... general appearance and probable function ..." (p. 94) and technological differences were relegated to some of the finer distinctions. The intent here is admirable, but the categories are not really explained in terms of function. Such items as "picks," "cleavers," and "scrapers" are not really functional terms until one specifies just what kind of material was being picked, cleaved, or scraped. Sieveking describes 14 kinds of tools (excluding hammerstones) in 6 major groupings which do not correspond closely with either of the two classifications mentioned above, or with my own. It might be noted that if the present series were classified by Sieveking's criteria, the tools would occur in each category in proportions rather similar to those of the Tampanian series.

In the Hungarian site of Vértesszöllös a series of stone tools has been found which has been dated in the general time of the Mindel or second glaciation. These tools do not include hand-axes, and thus have been compared favorably with tools of three non-Acheulian traditions: Clactonian and similar North European assemblages; Soan and other South East Asian types; and the African pebble tools. Their only unusual feature is in the small size of the tools.

A typology of the Vértesszöllös tools has been offered by Kretzoi and Vértes (1965) in which 500 identifiable artifacts are divided into 34 kinds. Most of these categories are based on shapes which I doubt were meaningful to the makers—it is difficult to believe that these people had in mind 34 or more discrete types of stone cutting tools and deliberately made one, to the exclusion of all others, each time a tool was manufactured.

Almost half of the tools are "choppers" or "pebble-tools" of some kind, and except for their smaller size, are apparently just like those in the other series being compared here. Various kinds of flake tools constitute the remainder of the series and include both scraping and cutting designs of great variety. There is no indication of anything like the discoidal flakes which are so prominent in the Soan series.

It is perhaps in the Oldowan, pre-hand-axe "culture" of Africa that one finds the greatest similarities to the Soan tools. The apparent great discrepancy in dating and the relation of each to Acheulian industries remain to be explained. Mary Leakey (1967) has provided a description of Oldowan artifacts of all types (not just the pebble tools) which now makes closer comparisons possible. Several types of "choppers" are described that appear to be only incidental variations of the same process of making a cutting edge on a pebble. Even the "proto-bifaces" are merely choppers with two edges, instead of just one, which happen to meet in a point. (If one makes enough such cutting edges on pebbles this form is bound to occur occasionally, and it should not be seen as a deliberate step in the direction of making true hand-axes.)

Of the other categories of tools described, Mrs. Leakey's "discoids" are clearly the same as my "discoidal flakes." In addition, her "polyhedrons" may also be just very thick discoids, a distinction which I chose not to make. These discoids and polyhedrons combined are not as common in the Oldowan series as are discoidal flakes in the present series of the Soan. This may be just sampling error, or possibly her "spheroids" might also be added to the group to make it comparable in numbers. If the spheroids are not just thick battered discoids, then their occurrence marks something of a distinction from the Soan.

Other tools, variously described as scrapers, burins, points, and utilized flakes, are broadly similar to the Soan tools. Levallois-like flakes and true blades seem to be absent from the Oldowan. A final minor distinction is the presence of hammerstones, anvils, and waste flakes, which indicate workshops or tool production sites for the East African material.

Some Paleolithic industries in the northwestern Punjab of the true Soan type have recently been described by Graziosi (1964:13–20). These tools are divided into categories which include hand-axes and cleavers as well as flake and pebble tools. The typology is unusual mainly in the emphasis (following Van Riet Lowe) on whether a pebble had been split transversely, diagonally, or longitudinally. Judging from the excellent illustrations, most of his longitudinally split pebbles (ortholiths) are what I have described as major flakes. The difference of opinion would seem to follow from each writer's estimate of the original pebble size as judged from the curvature of the remaining cortex. Given this three-part initial division, these pebble tools cannot be directly equated with other classifications mentioned here.

Graziosi's flake tools include those made by a Levallois-like technique, but otherwise are subdivided by appearance rather than manufacturing techniques. He contrasts wedge-shaped flakes with those of more uniform thickness, but beyond this each flake is given individual descriptive treatment.

It becomes clear that there is not a generally recognized system of classification of tool types in the Soan and related traditions. The six major systems noted here agree very little with one another, and the present writer has felt compelled to describe his series in still another manner. Perhaps with time and new discoveries, some consensus may be reached on the most meaningful manner of classification.

Evidence of Use

The only direct evidence of use to which these implements were put comes from examination of their cutting edges for what is generally termed "use flaking." This must be distinguished from minor flaking, which could come from two other sources. Deliberate secondary trimming by the toolmaker himself will usually remove larger flakes, and in a more regular pattern than use alone. The distinction between deliberate and use flaking is often only a matter of degree, and no claim is made here that every case is correctly diagnosed. This series of tools offers little problem in this regard as secondary trimming seems confined to fairly rough work.

The other source of fine flaking along cutting edges is rolling. If a tool is battered at random over its surface the most frequent flaking will be along the sharper edges. This can still be distinguished, in many cases, from use flaking. Rolling will remove flakes from edges in direct proportion to their sharpness: the sharper the edge, the more easily it flakes. In actual use of a tool, sharpness is not the only quality looked for in using an edge; length and straightness are also common factors. Among these tools there are many which had what appear to be good cutting edges as well as sharp protuberances which do not look like useful edges. In general, the fine edge flaking, or dulling, was most pronounced on the usable edges rather than being distributed only according to sharpness. Careful examination of edges for this distinction fails to show any evidence of rolling as a source of apparent wear.

The vast majority of the tools do show some edge battering which apparently resulted from use. Following is a breakdown of all tools into the categories discussed with an indication of how many of each appeared to show no use:

CURIOSITIES		
Hand-axes	3	all rolled
Flake tools	2	rolled
Pebble tool	1	deteriorated
MAIN SERIES		
Pebble tools		
Uniface	4	
Biface	30	3 unused
Discoids with cortex-wrap		
No surface flaking	5	
Cortex flaked	12	
Fracture flaked	8	2 unused
Both flaked	43	5 unused
Discoids without cortex-wrap		
No surface flaking	9	
Cortex flaked	4	
Fracture flaked	1	unused
Both flaked	23	
Levallois-like flakes	34	3 unused
Blades	16	
Indistinguishable pieces	21	8 unused

Only 22 pieces lack clear evidence of use flaking. This is no certain indication that they were not used, but merely that use does not show. It is interesting to note the high proportion of "unused" pieces in the indistinguishable category. Seven of these were flakes of no clear type and the other was a hemispherical split pebble. This suggests, but does not prove, that while the odd flakes may have been kept for use, the mere fact that they were not of any of the intended types meant that they were less likely to have been used.

No clear conclusions could be drawn from edge examination as to how the tools were used or upon what. Some hints might be seen in the type of use flaking which occurs. This can be either bilateral, where both surfaces are flaked by a cutting, chopping, or sawing motion, or it can be mainly unilateral, where one side only is flaked because of a scraping action.

Curiously, the unilateral, or scraper, flaking is not evenly distributed among the tool types and is comparatively rare. Of the 188 tools showing evidence of use, only 20 of these (just over 10 percent) include some or all of the scraper type of flaking. Six of these are Levallois flakes, four are blades, while only seven occur in all kinds of discoids and none on pebble tools. In terms of percentages of "used" tools, the "scrapers" occur as follows:

	"USED" TOOLS	"SCRAPERS"	PERCENTAGE
Pebble tools	31	0	—
Discoids	94	7	7.4+%
Levallois	31	6	19.3+%
Blades	16	4	25.0%
Indistinguishable	11	3	27.3%

The absence of scraper use from pebble tools and its near absence from discoidal flakes suggests a different kind of use from that involving Levallois flakes and blades and perhaps also the indistinguishable flakes.

If one assumes that the major use of stone scrapers is in the preparation of animal hides, their numbers here would indicate little of such activity. Other uses such as shaping spear shafts or digging sticks would be quite enough to account for the noted occurrence of scraper edge flaking.

Most of the tools have the kind of cutting edge that is quite effective for butchering animals. This writer has often used stone tools of many kinds to cut meat and has found them quite effective. The thickness of the cutting tool presents no great problem with meat which, unlike most materials, can be pushed to each side while the incision is deepened. What kinds of animals were butchered is, of course, not indicated by the tools, as they would have served for anything likely to have been encountered.

The size and form of some of the larger pebble tools suggests woodchopping as a possible use to which they may have been put. Oakley illustrates just this sort of thing being done by an Australian aborigine with a large, naturally sharp stone (1950:6). Experiments have shown that only green or growing wood can be chopped in this manner; attempts on dry wood do about as much damage to the stone tool as to the wood. (This observation suggests how simple the innovation of baton flaking might have been.)

In order to acquire more basis for speculating on the possibility of woodchopping with these tools, I carried out some experiments.

While making a number of tools duplicating the Soan techniques, I tried out a few on woodcutting. Finding that fresh wood could be cut with some success, I made a more controlled experiment. A bifacial pebble tool was made of hard basalt weighing just over two pounds. This was then used as a hand-held axe to chop through a growing branch of a Dutch elm tree. The branch was $2\frac{1}{2}$ inches in diameter and was cut through with 525 chops in approximately five minutes. Had I been more experienced with this kind of work it probably would have gone faster and with fewer strokes. The basalt pebble tool was not noticeably altered in its cutting efficacy by this use. Other kinds of stone experimented with, however, seemed to become much duller in only a hundred strokes.

The cutting edge of my basalt chopper, as compared with that of a freshly made and unused specimen, was visibly altered only by some minor flake removals. Since this edge condition seemed much like that on many of the Soan tools, the next obvious test was on the ancient tools themselves.

Two specimens of the bifacial pebble tool type were selected which seemed to both eye and touch to have identical qualities of cutting edges. One was then used, and the other was retained for later comparisons. The test was made on the same elm tree (which had been blown over in a windstorm, but retained its rooting and continued to grow in an accessible position). A branch of 3 inches in diameter was chosen and chopped into for the same 525 strokes. This time the branch was cut not quite halfway through.

The edge of the Soan tool appeared only slightly less sharp than the basalt specimen at the beginning of the test. At the end of the test it seemed not to be cutting as well as it had at the beginning, though my tiring arm may have been a factor. Several small chips were lost from the edge in the test, and the resulting scars were notably less smooth or polished than the rest of the edge.

The original condition of the tested tool would suggest it may well have been used to chop wood. Its edge had already become somewhat blunted and smoothed, and did not cut as well as the freshly made tool. Its condition is about what would be expected if it had once been used to chop off a branch or two, then discarded because of slight dulling of the edge.

This does not prove woodcutting to have been the actual use of these tools, but it indicates a reasonable possibility. The need for cutting off such tree limbs, too thick to break by hand, should be considered. Pointed wooden shafts for use as spears and as digging sticks would have been of major food collecting importance, and only with the aid of such pebble tools could such limbs be cut from live trees.

The importance of live branches over dead, dry wood lies in the method of giving them good points. This is easily done by burning the end in a fire for a few minutes and then scraping off the ashes. If the wood is fresh it will char gradually in from the surface and more so at the tip than farther back. A symmetrical point (as well as fire hardening) automatically results from this process. Dry wood does not become neatly pointed by fire treatment, as charring follows cracks as well as the surface.

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